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ON THE SUMMER PHYTO- AND ZOOPLANKTON OF LAKE PALAEOSTOMI

IV. Quantitative data on phytoplankton and relations with zooplankton

The biomass and other numerical indices of phytoplankton are given in Table; the biomass of zooplankton (the weight of jellyfish has been subtracted) has been added for the sake of comparison. It turns out that the algal biomass is different in different sample spots. One reason for it may lie in counting methods. Goryayev's chamber for counting blood elements is very small, and large colonies of blue-green algae may sometimes not fall into it. The average biomass of the water body is characteristic of highly eutrophic lakes, while the maximum values characterize hypertrophic lakes. For comparison we offer the summer biomasses of the algae in the littoral zone of the Black Sea in the years of average productivity (Основы . . ., 1979): in the eastern part 0.1—0.2, in the western part 0.4—5.0, in the northern part 0.1—0.4, in places less than 0.1 g/m³.

Although the horizontal distribution of phytoplankton was uneven, its dependence on salinity was not revealed. Some authors consider the salinity of 5‰ to be the critical limit for several organisms (Amspoker, McIntire, 1978), or 5—8‰ (Гаджиева et al., 1978), at which a sudden change of the dominating species occurs. In L. Palaeostomi the salinity did not exceed the above limits (maximum 6.62‰ (Тийдор, in print)) and therefore no essential differences in the dominating species occurred. In the lake open to winds and with a simple coast-line, plankton is probably distributed in dependence on the winds and streams even in the case of bigger differences in salinity. An analysis of Chkhaidze's material reveals that the distribution of the dominating species cannot always be connected with salinity, although the author himself admits the existence of a direct dependence (Чхаидзе, 1975). Regular differences occurred between the pelagic and littoral parts of the lake: in the littoral the biomass was considerably lower than the average of the lake, with the exception of sample spot 6 on the open leeward coast, where the biggest amounts of algae were found. Therefore, when calculating the average values, the above-mentioned spot was joined to the pelagic part (Table). Considering the distribution of the phytoplankton in the summer of 1964 and 1965, it appeared that the biomass was highest in the central part of the lake and lowest in the beginning of the canal where salinity was highest. In other seasons a different distribution was possible: the highest biomass in the river-mouth of the Pichora or in the beginning of the canal (Чхаидзе, 1975). We are of the opinion that the main role in the distribution of plankton is played by the wind.

There are many data on the increase of the biomass of phytoplankton with growing salinity (Baglin, 1972; Kaliyamurthy, 1975; Губина, 1974)

Summer plankton data of L. Palaeostomi in 1977

Sample spot	Php bm		H		H/bm		Zp bm		Php/Zp		Number of Php species	
	22. VII	8. VIII	22. VII	8. VIII	22. VII	8. VIII	22. VII	8. VIII	22. VII	8. VIII	22. VII	8. VIII
1*	3.45		1.88		0.54		0.39		8.85		21	
2*	4.62	7.32	1.76	2.59	0.51	0.35	0.65	0.04	5.28	197.76	24	25
3*	3.98		1.10		0.28		2.05		1.95		17	
4*	21.94	28.05	2.98	3.22	0.14	0.11	0.39	1.07	56.99	26.19	37	37
5*	6.76	39.61	1.41	2.74	0.21	0.07	0.80	1.58	8.48	25.13	24	37
6	144.60	125.38	1.84	2.22	0.01	0.02	1.61	1.69	90.04	74.10	31	25
8*	10.68	8.16	1.49	0.87	0.14	0.11		0.31		26.14	18	18
9*	50.96		2.08		0.04		0.34		151.20		31	
10*	9.63	28.69	0.61	2.50	0.06	0.09	0.98	1.04	9.83	27.56	21	16
11	82.15	33.02	0.15	1.44	<0.01	0.04	7.74	5.10	10.62	6.47	12	14
12 0 m	50.19	28.87	1.45	1.79	0.03	0.06	5.92	7.49	17.85	5.41	19	19
1 m		32.46		1.82		0.06						17
2 m	105.63	40.53	0.50	1.87	<0.01	0.05					15	20
13		23.06		2.09		0.09	5.18	4.34		5.31		23
14	20.22	100.54	0.76	2.44	0.04	0.02	6.68	8.42	3.03	11.95	22	16
15	119.35		0.51		<0.01		5.80	8.10	20.59		12	
16*		6.93		3.22		0.47		1.75		3.95		34
Middle part												
0 m	31.81		0.94		0.03						20	
1 m	36.24		0.63		0.02						18	
2 m	31.81		1.48		0.05						20	
Lake average	44.94	38.66	1.30	2.18	0.13	0.12	2.96	3.75	32.06	55.25	22	23
Pelagial average	69.11	54.84	0.92	1.93	0.02	0.05	5.55	6.16	28.43	20.65	19	19
Littoral average	14.00	19.79	1.66	2.52	0.24	0.20	1.43	2.81	34.65	57.05	24	28

Notes: Php — phytoplankton, Zp — zooplankton, bm — biomass (g/m³), H — species diversity index, * — littoral sample spots. The indicated averages include sample spot 16 (L. Maloye Palaeostomi).

and on the decrease of the species diversity index (H) in this case (Castenholz, 1960; Walker, 1975; Нуриева, 1979). The same regularity can be seen in the phytobenthos (Sanders, 1979). In the water bodies where the brackish water complex has not been completely formed, the increase of salinity may call forth a decrease of biomass. Probably L. Palaeostomi also belongs to such lakes, but the material collected during one month only does not allow us to make any conclusions on the stability of the complex. The replacement of several dominating species by quite similar ones (as the comparison with data obtained 10 years ago) proves a certain unstability. In the Bay of Kura where, according to S. I. Uselyte (Уселите, 1959), the brackish water complex has not been formed either, a small rise of salinity increases the production of phytoplankton, while the further rise restrains it (Шулиене, Янкявичюс, 1976). According to D. Marčiulenene (Марчюлене et al., 1976) the penetration of the marine water into the bay decreases photosynthesis 1.5—5 times and the number of phytoplankton 3—58 times. Often the observation of the influence of salinity is complicated due to disturbing factors. According to A. I. Rudzroga the biomass of phytoplankton in the Bay of Riga decreases in the direction of the open sea, i. e. with the increase of salinity. According to the same data the water near the shore contains considerably more biogenes (Рудзрога, 1977). Differences between the littoral and pelagic spots of L. Palaeostomi show that the species diversity index of phytoplankton decreases with the rise of salinity. This regularity was still more pronounced in the Uzboi lakes with their different salinity (Лаугасте, 1980), where only the pelagic plankton was under observation. The numerical values of H, the ratio of H and the biomass as well as the average number of species in a quantitative sample taken in the pelagic part are considerably lower than those of fresh-water lakes which the authors have had an opportunity to observe. They are closest to those of the Estonian hypertrophic lakes which reveal obvious symptoms of pollution. The ratio of the biomasses of phyto- and zooplankton also coincides with that of the Estonian lakes of the same type, where the index is almost 40 (in one case over 400; Лаугасте, Порк, 1980). In the polluted lakes of Byelorussia the ratio has been mentioned as 11.7—25.8 (Якушко et al., 1977), in the highly eutrophic lakes even as 230.8 (Захаренкова, 1962). In the Baltic Sea at the salinity of 1.9—10.0‰ the ratio of the biomasses of phyto- and zooplankton equals 5.1—12.1, in the case of the water bloom about 85. The minimum value of the ratio occurred at the salinities of 7.2 and 10.0‰, i. e. no correlation was observed between the ratio and salinity (Schnese, 1973). In the Mid-Caspian, at the almost simultaneous maximum of phyto- and zooplankton, their ratio was 110, in the South-Caspian 107 (calculated on the basis of data by G. B. Babayev (Бабаев, 1968)). In the big eutrophic (with some mesotrophic features) L. Peipsi the ratio was 8.5, in the more eutrophic L. Pihkva 10 (Ястремский, Яковлева, 1975), in L. Balaton 28.6 (calculated on the basis of the average biomasses, according to I. Spodniewska (1974)). In cultures the system is said to preserve a balance when the figure is near 10 (Крючкова et al., 1975). In nature, especially in relatively hard-water lakes ($HCO'_3 > 100$ mg/l) the system may be considered stable even when the figure is higher. Still, very high figures (near 100) are temporary, since they are caused by the bloom of the phytoplankton.

Comparing the amount of the zoo- and phytoplankton in different sample spots, no direct dependence of the horizontal distribution among these groups is revealed although the biomasses of both groups in the pelagic region are considerably higher than those in the littoral part. In literature one can find data both on the positive and negative correlation between the zoo- and phytoplankton; in several papers the existence of a direct dependence between them is negated. According to the data on the Ukraine (Пидгайко, 1969), phytoplankton restrains the development of zooplankton if the biomass of the former exceeds 1300 g/m^3 — a figure which in the case of L. Palaeostomi should be decreased by more than 10 times. The great variety and discrepancy of the data is explained by the fact that the relations between the zoo- and phytoplankton differ seasonally as well as in lakes with a different degree of trophication, where the dominating species are different. The morphometry of the lake is very important — in the big and deep water bodies the algae are not distributed homogeneously during the bloom, and zooplankton has thus an opportunity to leave the places where the concentration of phytoplankton is high. The degree of the influence of the wind, the existence of stratification, and the amount of detritus depend on the area and depth of the water body. They, in their turn, have an influence on the relations between the zoo- and phytoplankton. Some Japanese investigators are of the opinion that the problem of the dynamics of plankton offers many possibilities for the improvement of the theory of non-linear mechanics since the solution of the problem can be achieved only by a cooperation of biologists and physicists (Ichiye, 1954). In L. Palaeostomi the restraining influence of the phytoplankton on the number of the zooplankton was not to be seen directly if not to consider the fact that the high biomass of the algae and the abundance of detritus in the lake determined the dominating group in the zooplankton — the rotifers. It has been mentioned even earlier that the rotifers can well stand both eutrophication and pollution (Цееб et al., 1962).

To elucidate the stability of the numerical indices of the plankton, we took samples once more in two weeks. The average figures turned out to be rather close. Multiple changes in the biomass in some spots refer to the uneven distribution of plankton in the water of the lake. The amount of phytoplankton in the open water decreased, but in the littoral part it increased, and so did the number of species and the species diversity index. The absence of big fluctuations means that the plankton composition is balanced. Comparing our figures with the data of 1964 and 1965 (Чхаидзе, 1975) it turns out that in the summer of 1964 the average biomass was higher (93.69 g/m^3) and in 1965 lower (17.77 g/m^3) than in 1977. The dominating group in our quantitative samples were the diatoms, forming 17.4—100% and on the average 79.3% of the biomass of phytoplankton. In the net samples the role of the blue-green algae seemed to be bigger than that of the diatoms. Thus it is probable that our numerical data do not reflect correctly the relationship of the algae groups. The reason seems to lie in the fact that a too small chamber was used for counting. When taking samples, Ruttner's batometer decreases the role of the blue-green algae, pushing aside the colonies from the surface layer which has a horizontal bottom.

It is not excluded that in case of a more complete counting of the blue-green algae, their biomass in 1977 would have been as high as in 1964 or even higher. Still, it is obvious that no great shifts towards eutrophication have taken place during 10 years.

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PALEOSTOMI JÄRVE SUVINE FÜTO- JA ZOOPLANKTON

IV. Fütoplanktoni kvantandmed ja seos zooplanktoniga

Artiklis on esitatud andmeid fütoplanktoni biomassi ja teiste näitajate kohta (tabel), võrdluseks on lisatud zooplanktoni biomassi väärtus, millest on lahutatud meduuside mass. Fütoplanktoni horisontaalne jaotus on ebaühtlane. Füto- ja zooplanktoni jaotuses pole sõltuvust märgata, kuigi pelagiaalis on mõlema biomassid tunduvalt suuremad kui litoraalis. Nende rühmade biomasside suhe, samuti muud fütoplanktoni näitajad on lähedased Eesti hüpertroofsete järvede omadele. Kui võrrelda käesolevas töös toodud fütoplanktoni näitajaid andmetega 1964.—65. aastast (Чхаидзе, 1975), ilmneb, et suuri nihkeid eutrofeerumise suunas kümne aasta jooksul toimunud ei ole.

Реэт ЛАУГАСТЕ, Юта ХАБЕРМАН

ЛЕТНИЙ ФИТО- И ЗООПЛАНКТОН ОЗЕРА ПАЛЕОСТОМИ

IV. Количественные данные фитопланктона и его связь с зоопланктоном

Приводятся биомасса и другие количественные показатели фитопланктона. Для сравнения добавлена биомасса зоопланктона (без биомассы медуз). Горизонтальное распределение фитопланктона неравномерное. Взаимосвязь в распределении фито- и зоопланктона не выявляется, хотя биомассы обоих в пелагиали значительно больше, чем в литорали. Соотношение биомасс этих групп, а также другие показатели фитопланктона близки к показателям гипертрофных озер Эстонии. При сравнении приведенных данных с данными 1964—1965 гг. (Чхаидзе, 1975) выясняется, что больших сдвигов в направлении эвтрофирования за десять лет не произошло.